REMARKS

Claims 1-53 are pending in the application and are subject to restriction. Applicants previously elected to prosecute the subject matter recited in claims 1-30. Should Examiner Yuan find claims 1-30 allowable, applicants authorize the Examiner to cancel non-elected claims 31-53 by Examiner's amendment. Applicants respectfully submit that claims 1-30 are allowable over the prior art cited in the Office Action for the following reasons.

Before addressing the merits of the Action, applicants offer the following comments to assist the Examiner in appreciating the differences between the prior art and the claimed invention. Initially, applicants appreciate the Examiner's thorough review of the claimed invention and prior art, and the detailed comments provided in the Office Action that provide the bases for the prior art rejections.

Various embodiments of the invention are premised in part on the discovery by the applicants of a fuel cell that is capable of processing sulfur-containing hydrocarbon fuels without the need to reform the fuel prior to introduction into the fuel cell. As stated in the Background of the Invention section of the specification, it has been proposed to replace hydrogen with commercially available and more economical hydrocarbon fuels, but that such raw fuels "are not currently in use as a fuel source suitable for a fuel cell because these fuel cells contain relatively high levels of sulfur" (page 2, lines 19-23). The prior art disclosed numerous methods of reforming the sulfur-containing fuels into hydrogen gas, as disclosed on pages 3 and 4 of the specification. Anumakonda, *et al.*, U.S. Patent No. 6,221,280 ("Anumakonda") describes yet another mechanism of reforming sulfur-containing fuels into hydrogen gas and carbon monoxide, ***prior to*** feeding the hydrogen gas to a solid oxide fuel cell.

The applicants discovered a fuel cell that is capable of processing a sulfur-containing fuel without the need for prior reformation, as disclosed in the prior art such as Anumakonda. Applicants therefore claim a solid oxide fuel cell that includes a solid electrolyte, a ceramic-metal composite anode, a cathode, and a fuel that includes a sulfur-containing hydrocarbon having a sulfur content of from about 1 ppm to about 5000 ppm. None of the prior art discloses or suggests a solid oxide fuel cell capable of directly processing, without reformation prior to introduction into the fuel cell, a sulfur-containing hydrocarbon as recited in the present claims.

On pages 1-5 of the Action, claims 1-6, 9-27, and 30 are rejected under 35 U.S.C. §103(a) as being unpatentable over Wallin, U.S. Patent No. 6,017,647 ("Wallin") in view of Anumakonda. The Action recognizes that Wallin fails to "disclose the characteristics of the fuel used for the . . . solid oxide fuel cell," and relies on Anumakonda as teaching the "use of sulfur-containing heavy hydrocarbon fuels for a solid oxide fuel cell" (Action at page 2). The Action further alleges that Anumakonda teaches that "the use of a catalytic partial oxidation process to produce fuel enables a simplified overall system design" (Action at page 2). Accordingly, the Action concludes that "it would have been obvious to. . . use a fuel having sulfur content of at least 50 ppm to about 3000 ppm on the solid oxide fuel cell of Wallin, because Anumakonda et al. teach the processing and use of a sulfur-containing hydrocarbon fuel, such as JP-8, to simplify the overall design of a fuel cell system" (Action at page 2). This rejection is respectfully traversed.

As stated above, Anumakonda does not teach using a sulfur-containing hydrocarbon fuel as the fuel source for a solid oxide fuel cell. Indeed, Anumakonda teaches directly away from this aspect of the invention by requiring reformation of the fuel by use of a catalytic partial oxidation process to yield hydrogen and carbon monoxide, and then introduction of the hydrogen to the solid oxide fuel cell. Thus, Anumakonda discloses at best a solid oxide fuel cell containing hydrogen as the fuel source.

Even assuming as true the allegations in the Action regarding Anumakonda's reaction system providing a simplified overall system design, the system that is simplified is a system used to reform sulfur-containing hydrocarbons. This is Anumakonda's contribution to the prior art — an alleged simplified sulfur removal process, and not a simplified fuel cell. Indeed, it is hard to imagine how Anumakonda's sulfur reformation system could somehow simplify Wallin's fuel cell, when Wallin requires no reformation. A person skilled in the art would not be motivated to modify Wallin's already simple solid oxide fuel cell by including at least two unit operations (vaporizer/mixer 21, and reactor 13) prior to the fuel cell. Combining Wallin with Anumakonda significantly complicates Wallin's system. The combination does not simplify it.

Accordingly, a person skilled in the art would not have been motivated to make the hypothetical combination asserted in the Action because such a combination increases the complexity and cost of Wallin's fuel cell. Even if the disclosures were combined, the combined teachings would not result in a solid oxide fuel cell including a sulfur-containing

hydrocarbon, as recited in the present claims. Rather, the combined teachings would result in sulfur-removal unit operations up-stream from Wallin's fuel cell, and then introduction of hydrogen only into the fuel cell. The combination of Wallin and Anumakonda therefore fails to render obvious the present claims, and applicants respectfully request that the Examiner reconsider and withdraw this rejection.

On pages 5-7 of the Action, claims 1, 2, 7, 8, 20, 28 and 29 are rejected under 35 U.S.C. §103(a) as being unpatentable over Wallin in view of Fasano, *et al.*, U.S. Patent No. 6,051,330 ("Fasano") as evidenced by Yamauchi, *et al.*, U.S. Patent No. 4,228,033 ("Yamauchi"). The Action recognizes that Wallin fails to "disclose the characteristics of the fuel used for the . . . solid oxide fuel cell," and relies on Fasano as teaching "the use of light hydrocarbons, such as methane, propane, ethanol and methanol." (Action at page 6). The Action alleges further that the "typical sulfur content in the methanol is found to be between 1 to 5 ppm as documented by Yamauchi et al." (Action at page 6). The Action then concludes that "it would have been obvious. . . to use a light hydrocarbon fuel, such as methanol having sulfur content of 1 to 5 ppm, on the solid oxide fuel cell of Wallin, because Fasano et al. teach the use of a light hydrocarbon fuel can reduce the build-up of carbonaceous material in the anode of a solid oxide fuel cell" (Action at page 6). Applicants respectfully traverse this rejection.

Yamauchi is not relevant to the present invention, and is non-analogous art with respect to Wallin and Fasano. Even if Yamauchi discloses the presence of sulfur impurities in the methanol that it uses, this disclosure does not suggest that the methanol disclosed by Fasano includes any sulfur. Indeed, the methanol utilized by Yamauchi was purposefully chosen to include sulfur so that it could deactivate the catalyst in the conventional hydro-cracking reaction disclosed therein. This deactivated catalyst then is reactivated in accordance with Yamauchi's invention.

Yamauchi does not disclose that the "typical sulfur content in the methanol is found to be between 1 to 5 ppm," as alleged in the Action. In fact, the sulfur present in the methanol used in Yamauchi's examples is atypical, and is used on purpose to deactivate the catalyst so that Yamauchi can carry out its invention to reactivate it. Methanol typically does not contain sulfur in amounts above 0.5 ppm. Applicants are attaching hereto documents describing the sulfur content of commercially available methanol for use in fuel cells as typically being zero, and at most about 0.5 ppm.

Fasano also does not disclose or suggest that any of the hydrocarbon fuels described therein as useful in a solid oxide fuel cell contain any sulfur. A person skilled in the art therefore would not have been motivated to combine Fasano's teachings with Yamauchi's sulfur-enriched methanol because Yamauchi specifically used methanol with higher amounts of sulfur than typical to deactivate the hydro-cracking catalyst described therein. Any combination of Fasano and Wallin with Yamauchi therefore is improper. In addition, a skilled artisan would not have used Yamauchi's sulfur-enriched methanol in Fasano or Wallin because the prior art (*e.g.*, Anumakonda) taught that sulfur can poison the catalyst in the solid oxide fuel cell to a point where the catalyst becomes completely deactivated (col. 2, lines 50-52). Accordingly, any combination of Yamauchi with Fasano or Wallin would destroy the fuel cell. Combining documents in a manner that destroys or frustrates the fundamental purpose of the primary reference is the antithesis of obviousness.

Fasano also does not teach that the use of a light hydrocarbon fuel can reduce the build-up of carbonaceous materials in the anode. Rather, Fasano describes conventional light hydrocarbons as useful fuels, and mentions that heavier fuels have been used but the internal reforming is not efficient enough to reform the fuel and carbonaceous material is built up in the anode. Fasano recognizes a problem with some heavier fuels, but in no way suggests that light hydrocarbon fuels somehow "reduce the build-up of carbonaceous materials." It therefore is not clear why a person skilled in the art would have been motivated to use Fasano's light hydrocarbon fuels as the fuel source for Wallin's solid oxide fuel cell.

In sum, skilled artisans would not have been motivated to combine the cited art in the manner suggested in the Action. Even if combined, the combined teachings do not disclose or suggest the claimed invention because the art fails to disclose that the methanol fuel of Fasano has a sulfur content within the claimed range — indeed, it suggests otherwise. The combination of Wallin, Fasano, and Yamauchi therefore fails to render obvious the present claims. Accordingly, applicants respectfully request that the Examiner reconsider and withdraw this rejection.

In view of the foregoing, applicant respectfully submits that the present claims are in condition for allowance. An early notice to this effect is earnestly solicited. Should there be any questions concerning this response, Examiner Yuan is invited to contact the undersigned at the telephone number listed below.

Respectfully submitted,

9/17/03
Date

Patrick A. Doody
Reg. No. 35,022

HUNTON & WILLIAMS
1900 K. St., NW
Washington, D.C. 2006-1109
(703) 714-7645